AVIATION
AND
AERONAUTICAL ENGINEERING

Photo by Central News

British Observation Kite Balloon. The U. S. Army Is Starting a Lighter-Than-Air Station

NOVEMBER
15th
1916

PRICE
Ten
Cents

SPECIAL FEATURES

TESTS ON AIR-SPEED METERS
THE NEW STURTEVANT AERONAUTICAL ENGINE
COURSE IN AERODYNAMICS AND AIRPLANE DESIGN
A WIRE BENDER FOR THE AIRPLANE FACTORY
GOVERNMENT INSPECTORS IN AIRPLANE FACTORIES

PUBLISHED SEMI-MONTHLY
BY
THE GARDNER, MOFFAT CO., INC.
120 W. 32nd ST. NEW YORK

VIBRATION cannot loosen the simple pinned connections of the Sturtevant steel fuselages. The structural sections are fastened directly to one another and there are no steel fittings to work loose on wooden ends.

Sturtevant
REG. U. S. PAT. OFF.
AEROPLANE COMPANY
Jamaica Plain, Boston, Mass.

HALL-SCOTT

THE HALL-SCOTT MOTOR CAR CO., INC., announce two new models in their aeroplane engines, a development in their well known Type A-5 and Type A-7, six and four cylinder equipments, rated at 90 and 125 H.P., respectively. These new engines show increased power with no increase in weight over Types A-5 and A-7, have successfully passed all required running tests at the Hall-Scott factory, have been thoroughly tried out in aeroplanes under actual flying conditions with equally satisfactory results and are offered to the Hall-Scott customers with the same assurance of satisfaction that has been obtained in Hall-Scott equipment in the past.

This new equipment is placed in the following class:

Type A-7a, . . . 100 H.P.
Type A-5a, . . . 140 H.P.

HALL-SCOTT MOTOR CAR CO., Inc.

General offices:---818 Crocker Bldg., San Francisco, Calif.
Eastern representative: F. P. Whitaker, 165 Broadway, N. Y.

THE NEW WATER SPORT OF THE SUPERMAN

Instruction

in a General Aeroplane Co's Verville Type Flying Boat will convert the ardent speed motor boat enthusiast to the virile man making sport of flying

"PREPAREDNESS"

Office ~ 1501 East Jefferson Ave.

GENERAL AEROPLANE CO. Detroit U.S.A.

Hangars Old Detroit Motor Boat Site

BURGESS FLYING BOAT

After conclusive tests the Burgess Company offers a water and air craft ideal for sportsmen

Safety and comfort never before attained in flying is realized in this latest model, built under the patents of Burgess, Curtiss and Dunne

The crew is seated in a steady, seaworthy hull, provided with wind and spray shields deep cushions, lockers, and all the appointments of a modern high-speed launch

Absolute inherent balance is assured by the Dunne system, a balance as certain and simple as that afforded by the keel of a sailing yacht.

Steering is centered in a single wheel with duplicate control for pilot and passenger.

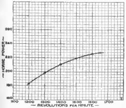
The engine may be started without leaving the cockpit.

The construction is worked out with a nicety of detail which must be seen to be appreciated.

THE BURGESS COMPANY, Marblehead, Mass.

NOTICE

Owing to changes and improvements our 5" x 7" eight-cylinder motor, formerly known as Model "VX" rated at 160 horsepower, will hereafter be known as Model "VX-3" and will be rated at 200 horsepower The following is a record of electric dynamometer test of stock motor "VX-3" No 3512 as delivered from the Production Department.



Duration of test (minutes)	60
Average R P M	1403 33
Average load on scales (lbs)	449 64
Average horsepower	**218 26**
Maximum observed horsepower	210 50
Minimum observed horsepower	208 10
Total Gas. consumption (lbs)	111 30
Total Gas. consumption (U S gals)	18 10
Gas. consumption per hour (lbs.)	111 30
Gas. consumption per hour (U S gals)	18 10
Gas. consumption (lbs. per H P. hour)	**.528**
Total Oil consumption (lbs.)	6 50
Total oil consumption (U S gals.)	844
Oil consumption (U. S gals per hour)	**.844**
Oil pressure—start of test (lbs.)	71 00
Oil pressure—end of test (lbs)	72 00
Oil pressure—maximum test (lbs.)	74 00
Oil pressure—minimum test (lbs)	68 00
Average inlet water Temp (F)	116 90
Average outlet water Temp (F)	140 50

CURTISS AEROPLANE & MOTOR CORPORATION

Buffalo, N. Y.

NOVEMBER 15, 1916 **AVIATION AND AERONAUTICAL ENGINEERING** VOL. I. NO. 8

INDEX TO CONTENTS

THE GARDNER, MOFFAT COMPANY, Inc., *Publishers*
120 WEST 32D STREET NEW YORK

SUBSCRIPTION PRICE: ONE DOLLAR PER YEAR. SINGLE COPIES TEN CENTS. CANADA AND FOREIGN: ONE DOLLAR AND A HALF A YEAR.

ISSUED ON THE FIRST AND FIFTEENTH OF EACH MONTH. FORMS CLOSE FIVE DAYS PREVIOUSLY. ENTERED AS SECOND-CLASS MATTER, AUGUST 3, 1916, AT THE POST OFFICE AT NEW YORK, N. Y., UNDER ACT OF MARCH 3, 1879.

United States Navy airplane designed and built under direction of the Bureau of Construction and Repair in Washington. This machine is equipped with two Curtiss VX 160-horsepower engines, but V3 200-horsepower Curtiss engines are soon to be installed. The dimensions are Span 57 feet, chord 9 feet 6 inches, gap 10 feet, total supporting surface 1000 square feet, full flying load 6000 pounds. Speed range, estimated, 45 miles an hour to 90 miles an hour

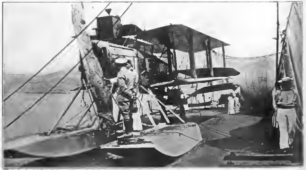


Photo by Central News Photo Service

A British Naval airplane, with floats. The dissembled wings are all ready for swinging into position for assembly.

President and Editor
LESTER D. GARDNER

Military Editor
PHILIP J. ROOSEVELT

AVIATION AND AERONAUTICAL ENGINEERING

Technical Editor
A. KLEMIN, A.C.G.I., B.Sc., S.M.
Instructor in Aeronautics
Massachusetts Institute of Technology

Managing Editor
HERBERT M. WILLIAMS B.S.

Vol. 1 November 15, 1916 No. 8

AIRCRAFT manufacturers are now experiencing the same difficulties that in the past have confronted other great industries After the Civil War a great wave of railroad building swept the country and the demand for civil engineers could not be met. When electricity became a commercial necessity good electrical engineers were at as great a premium as aeronautical engineers are to-day.

With new manufacturers entering the field, with present factories expanding, an unprecedented demand has developed for aeronautical engineers. Constructors frankly acknowledge that the lack of capable designers and factory executives is a heavy handicap They are offering generous inducements to bring the right men into their organizations Money apparently is no object, for it is realized that success depends in no small measure upon securing the proper experts

Unfortunately, there are but few fitted for the open positions Engineers in other lines cannot qualify; their training and experience have run in different channels Students in engineering schools, seeing no indication that aviation would be offering attractive inducements, have neglected the opportunity of specializing in the new science. There are practically no engineers available

Regardless of how aeronautical engineers are secured, it is recognized that upon them largely depends the healthy growth and expansion of the industry. With big business in sight, money and material are comparatively easy to obtain, but engineering skill, an essential to success, must be developed by slow processes, study and experience.

Equipment for Army Aero Units Outlined

The office of the Chief Signal Officer, U S A., has issued a book containing 109 pages and entitled " Equipment for Aero Units of the Aviation Section (Tentative) " The book is divided into four parts, " Initial Equipment of an Aero Squadron with a Mobile Division," " Unit Equipment of an Aero Squadron with a Mobile Division," " Equipment of an Aero Company " and " Machinery, Tools, Equipment and Supplies for an Aero Base."

The minute care with which this tentative list of equipment has been worked out is a credit to the officers both at Columbus, N M, and in Washington Its concrete detail emphasizes anew the infinite number of things that must be provided. The issuance of this list demonstrates impressively the necessity of encouraging the entire industry in its broadest sense if the full benefit of the $17,000,000 which has been appropriated for Army and Navy aeronautics is to be realized.

Simplifying Nomenclature

AVIATION AND AERONAUTICAL ENGINEERING has adopted the nomenclature recommended by the National Advisory Committee for Aeronautics This nomenclature may lead to certain apparent inconsistencies and even, possibly, legal complications The use of the word " airplane " for " aeroplane " is a step forward The common pronunciation " areoplane " never failed to curdle the blood. It should now be laid to rest forever. However so many " aeroplane " companies are incorporated that in captions and titles the word must survive for years to come Our excellent English contemporary *The Aeroplane* can hardly be expected to adopt the American nomenclature no matter how kindly may be their feelings toward American airplane manufacturers.

The nomenclature is clumsy in one respect at least. " Hydroairplane " is conspicuous by its absence. Technically the National Advisory Committee is no doubt correct The heavier than air machines of today are all of common ancestry. The sort of landing gear is the only thing that really differentiates the three types of heavier than air flying machines which used to be called " aeroplanes," " hydroaeroplanes " and " flying-boats," and which are now to be called " airplanes," " airplanes with float landing gears " and " airplanes with boat bodies "

The adoption of the standard names " elevator," " rudder " and " aileron " has the advantage of doing away with all the confusion caused by the old words " horizontal " or " vertical rudder " which always caused a layman a few moment's hesitation before he got it clear whether a " vertical rudder " was one in a vertical position or one that controlled the vertical motion of the airplane

The exclusive use of " aileron " to replace " wing-flap " and " banking rudder " may lead to a little difficulty until constructors and others get into the habit of talking of " interplane ailerons " and " trailing edge ailerons "

In the same way, the rest of the nomenclature is good in so far as it makes for simplification, and it is with an eye to simplification that the nomenclature has been worked out. The abolition of old friends like " volplane," " fuselage " and " angle of incidence," to mention only a few, may come hard but AVIATION AND AERONAUTICAL ENGINEERING will use " glide," " body," " angle of attack," etc., always subject to the inevitable editorial slips.

Tests on Air-Speed Meters*

By S. J. Zeigler, Jr., U. S. N.

In the tests made at the Massachusetts Institute of Technology, the following instruments were calibrated, and an attempt was made to determine the nature of the errors they presented:

1. The Ogilvie Air Speed Indicator.
2. The Foxboro Indicator
3. La Trompe Anemometrique S. A. F (System E. Badin).
4. The Velometer (R. A. F. type)

Tests were also made of the nozzles and indicators separately to see whether (1) the tubes gave indications in accordance with the laws of aerodynamics, and whether (2) the indicators were correctly graduated.

The wind tunnel in the aerodynamic laboratory of the Institute was used to obtain known wind speeds. These speeds were measured by the side plate and alcohol gage. The different tubes were mounted in the tunnel, and readings were taken for the various wind velocities and angles of incidence. Readings were taken with the tubes connected to their indicating devices to get the calibration curves, and with the tubes connected to a spirit gage to check the performance of the nozzle. The indicators were also tested against a water column in order to

Fig 1. The Ogilvie Indicator

check their graduations. Attempts were made to determine the time lag of the indicators, but in no case was the time lag large enough to be measured with an ordinary stop watch. The time lag may be taken as negligible and will give no trouble under service conditions.

The results obtained are calibration curves of the complete instruments, and of the tubes and indicators separately. Unfortunately the maximum wind velocity obtainable in the tunnel is 42 miles per hour. Consequently, the air speed meters were tested only over the lower portion of their range, and for this reason the tests are incomplete and may be unfair to some of the instruments. On the other hand, about 40 miles per hour is a common stalling speed for most airplanes and for that reason tests over this range are the most valuable, and good air speed meters should be reliable at those low speeds.

THE OGILVIE AIR-SPEED INDICATOR

This instrument consists of a pitot tube for obtaining pressure, and a diaphragm gage for registering the pressure and indicating the speed. The pitot tube is shown in the photograph Fig 1. The gauge consists of two chambers separated by a delicate rubber diaphragm. Dynamic pressure is admitted to one chamber and the static pressure to the other. The difference of the dynamic and the static pressures distorts the diaphragm, and the motion of its center is communicated to the pointer by a fine silk thread. The thread passes upwards from the center of the diaphragm and takes a three-quarter turn around a delicate spindle or drum with its axis parallel to the plane of the membrane. It then takes two turns around the pointer spindle which has its axis perpendicular to the membrane, and its end is made fast to this spindle. The pointer spindle is controlled by a fine hair spring. The whole mechanism is very delicate, and is free from back-lash.

*Abstract of a Thesis by Assistant Naval Constructors S. J. Zeigler, Jr., and H. M. Pace, Jr., at the Massachusetts Institute of Technology. Published by the courtesy of Professor C. H. Peabody, Naval Architecture Department, Massachusetts Institute of Technology.

Two instruments were calibrated, the curves for which are given in Figs 2 and 3. The instrument of later type was found to be accurate to within one-half mile per hour at forty miles per hour. This is as precise as the gage can be read. The Ogilvie No. 659, an earlier type, over-indicates to the extent of two and one-half miles per hour at forty miles per hour. The gage can hardly be read more precisely than to within one mile per hour, still an error of two and one-half

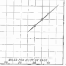


Fig 2. Calibration Curve of Ogilvie, Later Type

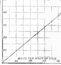


Fig 3. Calibration Curve of Ogilvie No 659 (Early Type)

miles per hour more than the true speed is serious. When an airplane is running near the stalling speed it is important that an anemometer at worst should not over-estimate the speed.

The hysteresis in the rubber diaphragm causes the pointer to lag somewhat in the lower part of the range, but when the speed has reached forty miles per hour the tension in the rubber is sufficient to eliminate nearly all of the lag.

It is important to know how the instruments will indicate when the tube is not pointing in the direction from which the wind is blowing. To determine this, the tube, Ogilvie No 659, was turned at varying angles to the wind, first to one side and then to the other. The results are shown by the diagram in

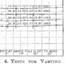


Fig. 4. Tests for Varying Angles of Incidence With the Ogilvie No. 659. Gage Reading Kept Constant. True Wind Speed Observed

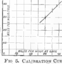


Fig 5. Calibration Curve of Ogilvie Later Type Tube at Angle of 20 Degrees to Wind

Fig. 4. This shows that the gage indication for a fixed speed will be slightly less for the tube inclined at an angle of twenty degrees to the wind than for the tube pointing directly at the wind. Ogilvie No. 659 was tested at several intermediate angles, but the variations were so small that the second instrument was tested only for the normal position and for twenty degrees to either side. See Figs. 2 and 5.

Ogilvie No 659 was given an additional test, by measuring the differences of pressure from the tube at different wind speeds. For this purpose the differential boiler draft gage installed in the laboratory was used. The indicating mechanism was then tested on a water column. The data is plotted in Fig 6. These curves contain the same information as the calibration curves, and serve as a check on them.

An attempt was made to measure the time lag in the instrument, but it was too small to be recorded with any certainty on the stop watch. It is estimated that the time lag is from one-fifth to three-fifths of a second, and it is believed that this is of no practical importance.

The tests of these instruments lead to the conclusion that the

Fig 6. Additional Calibration Curves. Tubes and Gages Tested Independently

Fig 8. Calibration Curves of Foxboro Instruments No 5 and No 8

Ogilvie indicators are good ones, but that they should not be used in service without first having been calibrated. The pitot tube, in spite of the small pressure difference generated, has always proved to be the most reliable means for measuring air speeds. Pitot tubes of the same design will give the same pressure differences at the same wind speeds, therefore, if standard gages can be manufactured for use with them it will not be necessary to calibrate each instrument separately.

The Ogilvie gages, as manufactured at present, are evidently not uniform. The difference between them must be in the rubber membranes used for the diaphragms, and it may be that the present state of rubber manufacturing does not admit of such a uniform product. Another objection to the rubber diaphragm is the hysteresis loop at low speeds, but as previously stated, this loop disappears at forty miles per hour, and is not very troublesome.

It will take a service test to show how long the diaphragms will last. If they give good results for even a reasonable period, say six months or a year, the short service presents no objection to their use, for cost is not of vital moment in airplane equipment. The Ogilvie indicator gives great promise.

THE FOXBORO INDICATOR

The Foxboro indicator is shown in the photograph, Fig 7. It is a combined pressure and suction instrument. The tube

Fig 7. The Foxboro Indicator

in front presents a large opening to the wind. In this opening is fitted a conical guard pointing into the wind, behind which is located the opening to a small pipe. This pipe is the only outlet from the cup shaped opening and it transmits dynamic pressure to the gage. The wind passing the tube creates a suction in the space enclosed by the frustrum of the cone. A small pipe, seen in photograph at the base of the cone to the left, transmits this suction to the gage. The gage is similar in construction to the ordinary vacuum type.

The pressure lead enters the small cylinders located in the case itself, which is made airtight by a gasket under the cover. When a difference of pressure exists between outside and inside of the two cylinders, they elongate or contract. The mo-

Fig. 9. Characteristic Curves of Foxboro No. 5. Wind Speed Held Constant. Angle of Tube to Wind Varied

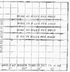


Fig 10. Characteristic Curves of Foxboro No 8. Wind Speed Held Constant. Angle of Tube to Wind Varied

tion is transmitted to the pointer by means of links to a circular rack which engages a pinion on the spindle.

Two of these instruments were tested and calibration curves shown in Fig 8 were obtained. Instrument No 8 shows only a small error for the range over which it was tested. Instrument No 5 did not show up so well, for it over-indicated by three miles per hour at a speed of forty miles per hour.

The same objections given against the Ogilvie instrument apply to this instrument also. Properly calibrated it will indicate the speed within one mile per hour. This is considered good enough for the uses to which it will be put.

The two Foxboros were given the same tests as Ogilvie No. 659 to determine the effect of inclining the tube to the wind. The results of these tests are given in Figs 9 and 10, which show a slight falling off in the indications of the gauge for in-

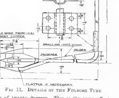


Fig 11. Details of the Foxboro Tube

clinations of twenty degrees. This is the same effect as observed in the case of Ogilvie No. 659.

The Foxboro Instrument Company supplied a tube of later manufacture than those used on the gages tested, and this tube was tested on the differential boiler gage in the laboratory. This tube is of the same type as the others, but has leads of larger cross-sectional area connecting the tube to the gage, is made of a material harder than the copper used for tubes in instruments 5 and 8, and is a more finished job. It would be reasonable to expect that more consistent results could be obtained with these tubes than with the rough copper ones. An objection to the copper tubes is that they are soft and are easily dented.

One of the Foxboro gages was tested on a water column and the pressures corresponding to the gage indications measured. The data for the tube and the gage are plotted in Fig 6. The two curves should be identical They converge at forty miles per hour, and it is possible that they are identical above this point. No data could be obtained for the upper range, however, and such a prediction is not safe.

The attempt to measure the time lag of this instrument was attended with the same results as in the case of the Ogilvie.

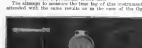


Fig. 12 La Trompe Anemometrique S.A.F (Systeme E Badin)

The time lag was appreciable, but was too small to be determined, and it is thought to be of no practical importance.

As stated for the Ogilvie air-speed indicators the Foxboro indicators of present manufacture should be calibrated individually before being used in service. The Foxboro tubes are not pure pitot tubes, but combine a section with the pitot pressure. For this reason the pressure difference generated at the nozzle is greater than for the pure pitot. This is an advantage, for the indicating mechanism does not have to be so delicate in order to secure the same precision, but it will probably be harder to manufacture uniform Foxboro tubes.

The discrepancies noted between the Foxboro instruments were due principally to the non-uniformity of the tubes. Two types of tubes were tested; the earlier type was of copper, and plainly a coppersmith job. Besides lacking uniformity and finish, the copper tubes were easily dented out of shape The later type of tube is made of a hard alloy and is a more finished product. It is to be expected that better results can be obtained with this type.

The Foxboro gages were larger and heavier than the other makes, but they compared favorably on test. These gages showed a small loop on the up and down readings, but it was not of sufficient magnitude to be a serious drawback. The loop is probably the combined effect of back-lash in the link and rack mechanism and hysteresis in the accordeon chambers. The Foxboro instruments have considerable merit, and will probably give good results when properly calibrated.

Fig 13 The Velometer, R.A.F. Type

LA TROMPE ANEMOMETRIQUE S. A. F (SYSTEME E. BADIN)

This instrument indicates the wind speed in kilometers per hour Its smallest indication is fifty kilometers per hour and it is graduated in steps of ten kilometers per hour as shown in the photograph, Fig. 12

Speeds of fifty and sixty kilometers per hour could be obtained in the wind tunnel, but it was impossible to reach seventy As a result only two indications of the instrument could be verified This precluded the possibility of obtaining a calibration curve. However, the tests which could be made were sufficient to show a serious defect in the instrument.

The pointer on the gage did not readily follow a variation of the wind, and would sometimes stick until the wind had changed as much as seven miles per hour when the pointer would move to its new indication in a jump This was evidently due to friction in the indicating mechanism. It was not possible to take the gage apart and seek the source of the trouble, but it is possible that when it is mounted on an airplane, where there is considerable vibration, the gage will not stick as it did while it was being tested.

The tube for obtaining the suction to transmit to the gage is of the double or compound Venturi type. A small Venturi tube is placed within a large one with its exit at the throat of the large Venturi The suction is taken at the throat of the small tube and is considerably greater than that obtainable with a single Venturi The difference of pressure at twenty miles per hour is between five and six times as great as that obtained from the pitot tube as used in the Ogilvie type This is a decided advantage, as the differences of pressure at most are very small.

When this instrument did not catch and the pointer did not remain in one position until the wind had fallen several miles per hour, the time lag was not large enough to be caught with an ordinary stop watch, but when the pointer did catch, the time lag could be made any amount whatever by simply varying the rate of change of wind velocity. In other words when the pointer caught, the instrument did not register small changes of wind velocity at all.

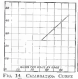


Fig. 14 Calibration Curve of Velometer No 788

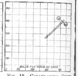


Fig. 15. Calibration Curve of Velometer No 788 With Tube at Angles of 10 and 20 Degrees to Wind

The type of tube, compound Venturi, employed in this instrument, appears to be a good one. It is light, compact and simple, and the difference of pressure developed is considerably greater than for the pitot type If the gage is calibrated to agree with the tube it makes no difference to what law the pressure difference conforms.

The gage supplied with the instrument was also light and compact, but was found to be wholly unreliable at speeds below forty-two miles per hour However, it would be reasonable to expect that this gauge would give better results at higher speeds, and when agitated by the vibrations of an air plane.

THE VELOMETER (R. A. F. TYPE)

In this instrument both a pressure and a suction are used and they are obtained in the same manner as in the Foxboro. A diagrammatic sketch is shown in Fig 13. The dynamic tube is a straight tube about twelve inches long. Two inches from the open end, a hollow cone is fitted over this tube. The wind blowing by the cone creates a suction, which is transmitted to the indicating device by a tube projecting into the cavity under the cone.

The indicating device is a special form of U-tube In principle it is as shown in the diagram. The indicating column of liquid is the one in the glass tube The other end of the tube divides, and half goes to one side and half to the other When the gage is inclined in a transverse plane the liquid falls as much in one branch as it rises in the other, and the level in the glass tube will be practically unchanged This eliminates one of the great drawbacks to the liquid indicating device, but it is subject to the limitations of the gravity controlled gage in the general discussion.

Only one of this type instrument was tested. This was tested with the tube pointing directly into the wind, and at angles of ten and twenty degrees to the wind The calibration curves are shown in Figs. 14 and 15 The latter shows a very small variation of the indication for the tube inclined at twenty degrees, and practically none when inclined at ten degrees. In general the error of this instrument was small. Also, it was not possible to read the gage more closely than to one mile per hour at the low speed over which the test was run

The tube of the Velometer is of the same general design as the Foxboro tube. It is made of aluminum which is soft and the same objections apply to the Velometer tube as to the Foxboro The principle objection to this indicator is that it is controlled by gravity, and, therefore, is subject to the errors already mentioned. On the other hand there is no back-lash, and practically no lag of any kind. It does not seem advisable to use a gravity controlled indicator on an airplane when a satisfactory spring controlled indicator can be obtained

SUMMARY

The test of the four air-speed meters are incomplete in that they cover the speed range up to only forty-two miles per hour, consequently, the conclusions drawn from the tests should be understood to apply to the instruments only at low speeds

Except as noted for La Trompe Anemometrique time lag was unimportant in all the instruments. To correct for errors due to the decreasing density of the air at higher altitudes it would seem desirable to have at least two speed scales on all gages, one calibrated for sea level density, and the other corrected so that it will give the correct speed at some fixed altitude With these two scales the aviator could interpolate mentally with sufficient precision for practical purposes

Carlstrom Wins Curtiss Marine Flying Trophy

The Curtiss Marine Flying Trophy was won by Victor Carlstrom, who flew 661.44 miles in less than ten consecutive hours in a twin-motored airplane, equipped with floats, on August 25.

Last year, the first year for which it was contested, the trophy was won by Oscar Brindley in a Martin seaplane with a flight of 554 miles. The Aero Club of California has been the holder of the trophy for the last year

The Curtiss Marine Flying Trophy offered by Glenn H. Curtiss through the Aero Club of America, consists of a trophy valued at $5,000 and $5,000 in cash or its equivalent, to be divided into five equal annual prizes. The winner receives $1,000 or equivalent and the club of which he is a member becomes the record holder of the trophy, which is to be held in custody by the Aero Club of America. A club becomes the owner of the trophy after the fifth year if it has been won for three consecutive years by its members.

Book Review

AERIAL RUSSIA

The Romance of the Giant Aeroplane

By Lieut.-Col. B. Roustam Bek

(John Lane Co., Pp 164. Price $1.00 net.)

The proceeds from the sale of the latest edition of this most interesting and popular book on airplanes are devoted to the Fund for the Families of British Aviators. The author, who is a Russian military officer describes in fascinating fashion early Russian efforts in aeronautics. Although the Imperial Russian Aero Club was started in 1908, the first serious work began in 1909 with the incorporation of the Kennedy Aeronautic Company After 1910 a number of meetings were organized and the keenest support was given by the government. Riabouchinsky at the famous Kutchino Institute took up work similar in character and almost equal in value to that of Eiffel. The interest in aviation in Russia soon became widespread and enthusiastic, thus being the case even amongst workmen who when engaged on airplane work, refused to go on strike.

An interesting account is given of the Sikorsky famous giant biplanes, the "Russian Knight" and the "Ilia Mourometz" amongst others The latter machine has a power plant of four engines, developing a total of 520 horsepower, with a speed of 105 kilometres per hour, and a load of 2½ tons. A series of cabins in the body extend for more than half its length, after which a gangway leads to the extremity of the tail, where a short ladder and trap door gives entrance to the tail deck

Although not in any way technical, the book is accompanied by some interesting photographs. Prior to the war facilities for flying instruction and airplane construction were almost on a par with those in Europe and America.

Victor Carlstrom Flies from Chicago to New York

Victor Carlstrom in a Curtiss Model R-4 airplane equipped with a standard VX-3 motor flew from Chicago to New York on November 2 and 3 The original intention was that the flight should be made between sunrise and sunset, but a forced landing at Erie, Pa, together with the attendant delay made it necessary for Carlstrom to spend the night at Hammondsport, N. Y. from which point he flew to New York the following morning

In a letter to Aviation and Aeronautical Engineering an official of the Curtiss Company gives the following brief summary of the flight and statement of the alterations in the R-4 machine which Carlstrom used.

Photo by Aero News Service

Victor Carlstrom.

"According to the official figures, his actual flying time from Chicago to New York City was 8 hours 28½ minutes. The machine he used was a standard model R-4 equipped with a 200 horsepower motor This is a standard VX 3 motor The only changes made with the machine were the addition of twelve feet of wing surface and the large gasoline tank to carry 205 gallons of fuel.

Despite the fact that Carlstrom made a forced landing at Erie the flight was an extremely creditable performance It established several new American records. The 452 miles from Chicago to Erie was covered in 4 hours, 17½ minutes, constituting a new American non-stop record.

The 315 miles from Hammondsport to Governor's Island were covered in 2 hours at 21 minutes with the aid of a strong northwest wind The land speed of this flight averaged 134 miles an hour, the highest speed ever attained in a cross-country flight in the United States.

It has also been pointed out that despite stops Carlstrom in his airplane made the best time between America's two largest cities that has ever been made by a vehicle driven the entire distance by a single individual.

CARLSTROM'S ACTUAL FLYING TIME

Left Chicago (Eastern time)	7 09 30	A.M
Arrived Erie Pa	11 27 00	A.M
Left Erie	2 34 00	P.M
Arrived Hammondsport	4 24 00	P.M
Left Hammondsport	6 35 00	A.M
Arrived New York	8 56 00	A.M
	Elapsed Time	Miles
Chicago to Erie	4 17 30	452
Erie to Hammondsport	1 50 00	200
Hammondsport to New York	2 21 00	315
Total	8 28 30	967
Average Speed, 114 miles an hour		

This is not only an encouraging performance for the machine Carlstrom drove, but Victor Carlstrom himself deserves great credit. The physical and mental strain of cross-country flying can only be met by a man of great nerve who has been trained by long hours of hard experience in the air. Outside of the United States Army there are almost no American fliers who could attempt such a trip Victor Carlstrom stands almost alone among civilian fliers in his training for cross-country work

In making his record-breaking flight Victor Carlstrom was assisted by using a Sperry synchronized drift set.

The Sturtevant Model 5A, Type 8, 140 H.P. Aeronautical Engine

The latest design of the Sturtevant aeronautical engine, manufactured by the B. F. Sturtevant Company, Hyde Park, Boston, Mass., is known as Model 5A, Type 8. By an extensive use of aluminum alloys, a saving of approximately 132 pounds in weight has been effected over the previous 140 horsepower models. It is announced that the weight of the engine with all accessories and with water is 550 pounds, making the weight per horsepower 3.95 pounds. This engine has been tested in the Hyde Park works for the past eight months, with a view to eliminating such minor troubles as might arise in any new design. The company reports that it has now undergone flying tests successfully, some at altitudes of over 10,000 feet, and that it is ready for the market.

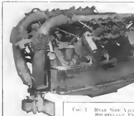


FIG. 1 REAR SIDE VIEW OF THE NEW STURTEVANT ENGINE

These engines are of the 8-cylinder type, 4-stroke cycle, and are water-cooled. The cylinders have a 4-inch bore and the stroke is of 5½ inches. The normal operating speed of the crank shaft is 2,000 revolutions per minute. The propeller shaft is driven through reducing gears, which can be furnished in different ratios. The standard ratio is 5 to 3, allowing a propeller speed of 1,200 revolutions per minute.

The construction is such as to permit of the application of a direct drive. The change from direct to gear drive or vice versa is simple and can be accomplished in approximately one hour according to the manufacturer's statement.

In the announcement of this motor the manufacturer claims that the workmanship and material entering in the construction are of the highest order. All parts are accurately machined and are interchangeable wherever possible, and all bearing surfaces are ground to size and perfect finish. The question of balance of reciprocating parts has received unusual attention. Special consideration has been given to the subject of heat treatment of high grade alloy steels, with the result that improved methods are claimed to have largely increased strength and have permitted weight reduction.

A notable feature of this engine is that with the exception of certain accessories all parts were made, assembled and tested in the Sturtevant works, where a large test house is maintained for testing engines under conditions closely approximating service requirements.

The general specifications for this engine, as given out by the manufacturer, are as follows:

Horsepower rating	148 at 2,000 revolutions per minute
Bore	4 inches = 102 mm.
Stroke	5½ inches = 140 mm.
Number of cylinders	8.
Arrangement of cylinders	V.
Cooling	Water. Circulation by centrifugal pump.
Cycle	Four stroke.
Ignition (double)	2 Bosch or Splitdorf magnetos.
Carburetor	Zenith duplex. Water jacketed manifold.
Oiling system	Complete forced. Circulating gear pump.
Normal crankshaft speed	2,000 revolutions per minute
Propeller speed, 3/5 crankshaft speed at normal	1,200 revolutions per minute
Stated power at 30-inch barometer	140 brake horsepower
Stated weight with all accessories but without water, gasoline or oil	514 pounds = 234 kilos.
Weight per brake horsepower	3.7 pounds = 1.68 kilos.
Stated weight with all accessories with water	550 pounds = 250 kilos.
Weight per brake horsepower with water	3.95 pounds = 1.78 kilos.

The following details of construction are available:

Cylinders.—The cylinders are cast in pairs from an aluminum alloy and are provided with steel sleeves, carefully fitted into each cylinder, a perfect contact being secured between the cylinders and the sleeves. The construction is such that when desired any sleeve can be replaced without injury to the cylinder proper. No difficulties due to expansion occur on account of rapid transmission of heat and the fact that the sleeve is always at higher temperature. A molded asbestos gasket is placed between the cylinder and the head, permitting the cooling water to circulate freely and also insuring a tight joint.

The cylinder heads are cast in pairs from aluminum alloy and contain ample water passages for circulation of cooling water over the entire head. Trouble due to hot valves according to claims, is thereby eliminated. The water jacket of the head corresponds to the water jacket of the cylinders, and large openings in both allow the unobstructed circulation of water. The cylinder heads and the cylinders are both held to the base by long bolts.

Valves.—The valves are located in the cylinder heads and are mechanically operated. The valves are constructed of hardened tungsten steel, the heads and stems being made from one piece. The valve rocker arms, located on the top of the cylinder, are provided with adjusting screws and check nuts permitting the adjusting screws to be securely locked in position once the correct clearance has been determined. The rocker arm bearings are lubricated by a compression grease cup. Cam rollers are interposed between the cams and the push rods in order to reduce the side thrust on the push rods.

Valve Springs.—A system of double springs is employed to reduce the stress on each spring and to insure reliability. A spring of extremely large diameter returns the valve, a second spring located on the cylinder base handles the push rod linkage. These springs, which are operated under low stress, are made from steel and are given a special double heat treatment.

Pistons.—The pistons are made from a special aluminum alloy, are deeply ribbed in the head for cooling and strength and are provided with two piston rings. These pistons are made light in weight in order to minimize vibration and to prevent wear on bearings. The piston pin is made of chrome nickel steel bored hollow and hardened, and is allowed to turn, both in piston and connecting rods. The piston rings are of the manufacturer's special design, developed after much experimenting in aeronautical engines.

Connecting Rods.—The connecting rods, of the H section type, are made from forgings of a special air hardening chrome nickel steel, which, after being treated, are claimed to have tensile strength of 280,000 pounds per square inch. The rods are machined all over. The big ends are lined with white metal and the small ends are bushed with phosphor bronze. The connecting rods are all alike and take their bearings side by side on the crank pin, the cylinders being offset to permit this arrangement.

Crankshaft.—The crankshaft is machined from high grade chrome nickel steel, heat treated. It is 2½ inches in diameter and bored hollow throughout to secure maximum strength with minimum weight. It is carried in three large, bronze-backed white metal bearings.

Base.—The base is cast from an aluminum alloy, thus securing strength and rigidity combined with light weight. The sides extend considerably below the center line of the crank shaft, providing an extremely deep section. At all highly stressed points deep ribs are provided to distribute the load evenly and eliminate bending.

Sump.—The lower half of the base is made of cast aluminum alloy. This collects the lubricating oil and acts as small reservoir for same. An oil filtering screen of large area covers the entire surface of the sump.

Propeller Shaft.—The propeller shaft is carried on two large annular ball bearings and is driven from the crankshaft by hardened chrome nickel steel spur gears that are contained within an oil casing integral with the base on the opposite

end from the timing gears. A ball thrust bearing is provided on the propeller shaft, which can be turned so as to take the thrust of either a pusher or a tractor. In the case of direct drive a stub shaft is fastened direct to the crankshaft and is fitted with a double thrust bearing.

Camshaft.—The camshaft is contained within the upper half of the base between the two groups of cylinders, and is supported in six bronze bearings. It is bored hollow throughout and the cams are formed integral with the shaft and ground to the proper shape and finish. An important development in

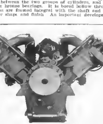


FIG. 2 FRONT END VIEW

the shape of cams has resulted in a maintained increase of power at high speeds. The gears operating the camshaft, magnetos, oil and water pumps are contained within an oil tight casing and operate in a bath of oil.

Lubrication.—Lubrication is provided by the forced circulating system the oil being supplied to every bearing under a high pressure by a rotary pump of large capacity, which is

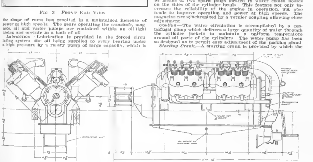


FIG. 3 FRONT ELEVATION AND SIDE ELEVATION

operated by gears from the crankshaft. The oil passages from the pump to the main bearings are cast integral with the base, the hollow crankshaft forming a passage through the connecting rod and the hollow camshaft distributing the oil to the camshaft bearings. The entire surface of the lower half of the base is covered with a fine mesh screen, through which the oil passes before reaching the pump. Approximately one gallon of oil is contained within the base, and this is continually circulated through an external tank by a secondary pump operated by an eccentric on the camshaft. This also draws fresh oil from the external tank, which can be made of any desired capacity.

Carburetor.—The carburetor is the Zenith duplex type. It is of double-barrel design with one float chamber and two jets, each supplying one group of four cylinders. The carburetor is located on the rear end of the motor, beneath the level of the engine base, thus permitting of gravity fuel feed, and it is connected to the cylinders by means of special water jacketed aluminum manifolds, the water jackets being cast integral. This type of manifold, it is said, not only provides the cylinders with a homogeneous mixture, but increases materially the fuel economy. There is less carbon formed in the cylinders and the exhaust is noticeably clean.

Ignition.—Ignition is accomplished by two reliable water proof magnetos placed face to face between the two groups of cylinders. Each cylinder is provided with double ignition

FIG. 4 VALVE PUSH ROD AND CAMSHAFT SYSTEM

by means of two spark plugs located in water cooled bosses on the sides of the cylinder heads. This feature not only increases the reliability of the engine in operation, but also tends to improve operation and power at high speeds. The magnetos are synchronized by a vernier coupling allowing close adjustment.

Cooling.—The water circulation is accomplished by a centrifugal pump which delivers a large quantity of water through the cylinder jackets to maintain a uniform temperature around all parts of the cylinders. The water pump has been so designed as to permit easy adjustment of the packing gland.

Starting Crank.—A starting crank is provided by which the engine can be readily started from the machine, and the crank handle can be extended to pass through a control board.

Self Starter.—The motor has been arranged to permit the application of an efficient air starter if desired. Any other suitable starter can, however, be applied.

Tachometer.—A tachometer giving accurate readings and which shows no vibration of the needle is supplied, either with or without a positive revolution counter for checking purposes.

Weight.—The weight of the engine, complete with carburetor, magnetos, starting crank, propeller hub flange and bolts but not including radiator and propeller, is 514 pounds. The weight, including cooling water in engine, is 550 pounds.

Course in Aerodynamics and Airplane Design*

By Alexander Klemin, A.C.G.I., B.Sc., S.M.

Instructor in Aeronautics, Massachusetts Institute of Technology, Member of the Aeronautical Society of Great Britain and Ireland

and

T. H. Huff, S.B.

Instructor in Aeronautics, Massachusetts Institute of Technology,

PART 1—SECTION 8

Biplane Combinations

Monoplane surfaces are aerodynamically the most efficient. Biplane combinations of any kind introduce interference between the planes, a diminution of the suction on the lower plane, with a consequently diminished efficiency. But as airplanes increase in size the difficulties of suitably bracing monoplane surfaces becomes very great, and their lifting capacity inadequate, and biplane construction must be resorted to.

Another important aspect of biplane construction is the possibility of obtaining longitudinally stable arrangements by staggering or displacing the wings relative to one another, and by introducing small angles between their planes, which is known as décalage.

The effects of staggering the planes for convenience of construction or with a view to increasing the range of view are to be considered within the province of practical construction.

Orthogonal Biplane Arrangements with Varying Gap Between Planes

An orthogonal biplane, as shown in Fig. 1, Setting No 1, is one in which the lines joining the leading and trailing edges of the two wings are both at right angles to the chord.

Experiments to which reference is given at the end of this section to determine the aerodynamic coefficients of such combinations with varying gap between planes have been carried out solely on wings of an antiquated type, and it is by no means certain that similar values would apply exactly to modern wings. In default of further exhaustive experimentation, the N. P. L. values must be taken as a guide, however. The results of the N. P. L. experiments showed that for normal angles of incidence:

(1) Drag per unit area of biplane combination was not appreciably greater than that of a similar monoplane surface.

(2) The lift coefficients as compared with a monoplane surface decreased considerably, and that the loss was the greater the smaller the ratio between gap and chord.

(3) Loss in value of lift/drag follows:

On the basis of these experiments the following table can be employed:

TABLE 1

FOR ANGLES OF INCIDENCE IN NORMAL FLIGHT

Ratio of gap to chord	0.40	0.80	1.00	1.20	1.60
Factor for K_y to reduce biplane lift from coefficients of a monoplane surface	0.61	0.70	0.81	0.86	0.89
Factor for K_y/K_x to reduce from coefficients of a monoplane surface	0.76	0.79	0.81	0.84	0.89

Distribution of Forces Between the Upper and Lower Wings of a Biplane

An indirect deduction from Dr. Hunsaker's experiments on the triplane the following figures may be given for the distribution of lift on the upper and lower wing of a biplane, with ratio gap to chord 1.2:

TABLE 2

Angle of Incidence	Percentage Lift Upper Wing	Percentage Lift Lower Wing
0	62%	38%
2	55%	45%
4	54%	46%
8	53%	47%
12	54%	46%

It is possible that the upper wing does not only carry a greater proportion of the lift, but that it also has a better L/D ratio and has a proportionately small drag. Still the standard assumption, as used by Dr. Zahm, among other eminent authorities, that 55 per cent of all the forces acting on a biplane may be taken as acting on the upper plane is sufficiently accurate for all practical purposes. The distribution of forces between the two planes is only useful in stress calculations in design, where an error of a few per cent will have little or no importance. In Eiffel's earlier experiments some interesting data for pressure distribution on the upper and lower wings of a biplane are given which bear out the above values.

Distinction Between Static and Dynamic Stability

It is important at this stage of the work to draw a distinction between static and dynamic stability. An airplane with static longitudinal stability has a righting moment when displaced from its position of equilibrium, which tends to bring it back to the position of equilibrium. This righting moment may be so violent, however, that the airplane may acquire a considerable rotational velocity (pitching velocity), overshoot its position of equilibrium, and then, with the intervention of a righting moment in the opposite direction, oscillate back and forth. In fact, the greater the static stability, the more violent may be the longitudinal oscillations.

In addition, therefore, there must be dynamic stability supplied by large tail surfaces, with a long arm about the center of gravity to damp out the oscillations which the static stability alone is unable to subdue. A concise but authoritative discussion of dynamic stability has already appeared in the columns of AVIATION (see appended references).

Stable Biplane Arrangements

We have seen that it is possible to secure a large degree of static stability at the expense of some loss in efficiency by the

*This course commenced in the August 1, 1916, issue of AVIATION AND AERONAUTICAL ENGINEERING, will be completed in 24 issues. It will embody the fundamental aeronautical data necessary for aeroplane design, and present the design of standard machines in complete, simple and systematic form.

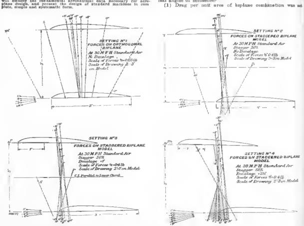


FIG. 1. VECTOR DIAGRAMS FOR DIFFERENT BIPLANE SETTINGS, USING R. A. F. 6 WING SECTION.

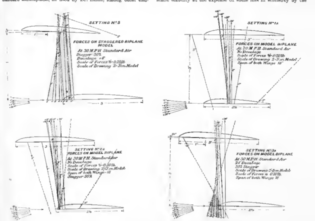


FIG. 2. VECTOR DIAGRAMS FOR DIFFERENT BIPLANE SETTINGS, USING R. A. F. 6 WING SECTION.

employment of wings with reversed curvature at the trailing edge It is possible to insure static stability also by the employment of biplane combinations with stagger and décalage Dynamic stability without preliminary static stability is impossible, but if an airplane is statically stable, dynamic stability is certainly possible

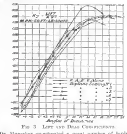


FIG 3 LIFT AND DRAG COEFFICIENTS

Dr Hunsaker investigated a great number of biplane arrangements at the Massachusetts Institute of Technology, with varying degrees of stagger and décalage, and found that with certain combinations

(1) Static longitudinal stability could be obtained with but little loss in aerodynamic efficiency.

(2) By suitable arrangements, the lift curve at the burble point can be flattened out and made to maintain its maximum for a wide range. This is particularly valuable, because it eliminates the danger usually attending stalling altitudes

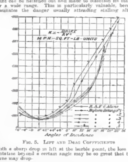


FIG. 5. LIFT AND DRAG COEFFICIENTS

With a sharp drop in lift at the burble point, the loss in sustentation beyond a certain angle may be so great that the machine may drop

Results of Experiments on Biplanes with Stagger and Décalage

In table 3 are given the summarized results for a series of tests on such combinations. In Figs. 1 and 2 are shown the corresponding combinations with the vector diagrams, in Figs. 3, 4, 5 and 6 are shown K_y and K_x curves, and in Fig. 7 are plotted these K_y against K_x curves for all the settings

To judge of the stability of any combination it is necessary to assume a number of positions for the center of gravity, to assume a normal flying angle of incidence, and to see whether displacement from the normal flying position is fol-

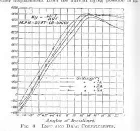


FIG 4 LIFT AND DRAG COEFFICIENTS.

lowed by the correct righting moment about the center of gravity If, for instance, the center of gravity for the setting No 4 of Fig 1 is placed as shown, between the vectors for 4 degrees and 6 degrees incidence, with normal flying angle 5 degrees, there will be statical stability. If the airplane dives to 2 degrees, the resultant force will have a clockwise mo-

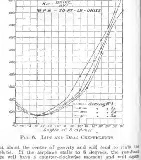


FIG. 6. LIFT AND DRAG COEFFICIENTS

ment about the center of gravity and will tend to right the machine. If the airplane stalls to 8 degrees, the resultant force will have a counter-clockwise moment and will again tend to restore the biplane to its normal position

In Table 3 the various settings are classified as stable and unstable, and it forms a very useful exercise to examine each combination from this point of view The comparative values

aerodynamically and the lift at the burble point are brought out clearly by Table 3 and by the K_y and K_x curves.

Even with these extensive tests it is impossible to draw definite conclusions as to the selection of any particular type, and the results should be regarded as more qualitative than quantitive. The qualitative results would prevent any fantastic combination being employed

Some of the main conclusions may be summarized as follows

(1) Stagger alone improves the aerodynamical qualities of a biplane, and flattens out the burble point, moves the vectors of force forward, but does not increase the stability to any appreciable extent

(2) Cutting down the lower wing of a biplane does not improve the stability, but it lessens interference, improves the aerodynamic efficiency, and flattens out the burble point.

(3) Increasing décalage combined with stagger produces progressive stability, but at the expense of aerodynamic efficiency

(4) Among the most promising arrangements seem to be

No 4 Décalage 2½ degrees, stagger 50 per cent. The stability is gained at the expense of but 4 per cent of the maximum lift/drag ratio, while a gain is obtained in all other properties.

No. 3A. Décalage 2.1 degrees, stagger 50 per cent, lower chord 83 per cent of the upper chord Here the stability is also attained at a loss of but 4 per cent on maximum lift/drag ratio, while the lift curve remains at its maximum over a range of 12 degrees.

Comparison of Aerodynamic Losses Involved in Obtaining Stability by Reversed Curvature Wings and by Stagger--Décalage Combinations

For reverse curvature wings giving static longitudinal stability the maximum lift is 17 per cent less and the maximum lift/drag ratio is about 14 per cent less than for a simple orthogonal biplane, as seen from the last column of Table 3. With a stagger décalage combination there is an actual increase in the maximum lift, while the L/D loss is only 4 per cent. The constructional difficulties in the region of the rear spar are also avoided. On the other hand, stagger involves increased length and resistance of wing struts and increased stresses in the drift bracing of the wings.

The relative merits of the two systems can only be decided upon by a practical comparative experience of the two types. In the authors' opinion, the stagger-décalage system is more likely to give better results than the reversed curvature wing system for ordinary machines. For very high speed machines, flying at a small angle of incidence, however, the reversed curvature biplane offers 20 per cent less resistance than the orthogonal biplane with R. A. F. 6 wing section In such machines, where a low maximum K_y coefficient and high landing speeds are permissible, the reversed curvature wing might be very advantageous from the point of view of high maximum speeds.

Aerodynamic Comparison Between the Monoplane and the Biplane

In Table 2 is given the correcting factors from monoplane values for biplanes with varying gap/chord ratios from the N. P. L. experiments. These will, although based on a wing section of an antiquated type, as already mentioned, be quite correct enough for angles of normal flight, 4, 6 or 8 degrees incidence. But for very low angles of incidence and for very high angles of incidence there is a discrepancy between the results obtained by the British investigators and by Dr. Hunsaker. The former concluded that at low angles of incidence the biplane drag was greater than that of the monoplane, while at high angles the biplane gave the better qualities. The later Massachusetts Institute of Technology experiments gave diametrically opposite indications. Since these experiments were conducted at a later date, and were carried out with R. A. F. 6 wing sections, they are probably worthy of more credence The following table has been deduced from the curves of Fig. 7, where K_y is plotted against K_x:

TABLE 4

LIFT/DRAG RATIO AND K_x FOR ORTHOGONAL BIPLANE, R. A. F. 6 WING SECTION, GAP/CHORD RATIO 1, GIVEN AS PERCENTAGE OF MONOPLANE VALUES FOR THE SAME K_y

K_y	K_y/K_x	K_x
0.0004	110	90
0.0006	107	93
0.0008	99	101
0.0012	85	115
0.0016	85	116
0.0020	79	126
0.0024	73	127

To consider L/D and K_x for the same values of K_y for monoplane and biplane is really a much fairer comparison than

TABLE 3

CHIEF PARTICULARS FOR STABLE BIPLANE ARRANGEMENTS

Type	Gap	Stagger	Upper Chord	Lower Chord	Decalage Degrees	Max K_y/K_x	Max. K_y	K_y/K_x where K_y = 0.0005	K_y/K_x where K_y = 0.0018	Range of Flat Burble Point in Degrees	Remarks on Stability with reference to Figs. 1 and 2
Monoplane.			C			1 15	1 16	0 90	1 24	2°	Unstable.
Biplane No 1	C	0	C	C	0 0	1 00	1 00	1 00	1 00	2°	Unstable
Biplane No 2	C	0 50C	C	C	0 0	1 00	1 06	1 00	1.23	3°	Resultant forces from 2½° to 10½° intersect near a single point If this point be the center of gravity there will be no pitching moment throughout this range. For the extreme range of flying angles from 1½° to 20½° the equilibrium is stable
Biplane No. 3	C	0 50C	C	C	1 0	1 98	1 03	1 00	1 01	6°	The large vectors for angles from 0° to 10° intersect near a point. If the center of gravity be at this point the equilibrium is neutral from 0° to 10° stable from 10° to 16° and unstable from 0° to −6° If center of gravity be placed low, at about the intersection of the vector for 4° and the lower chord, the equilibrium is stable for all the range from −2° to +16°
Biplane No 4	C	0 50C	C	C	2 5	0 95	1 03	1 00	1 02	4°	For a center of gravity located anywhere in the lower triangle bounded by the vectors for −2° and −5° the equilibrium is stable longitudinally throughout the entire range of pitching angle −5° to +20° Very good arrangement.
Biplane No. 5	C	0 50C	C	C	4 0	0 87	1 04	0 90	0 99	4°	Excessive stability Machines suitable for amateurs.
Biplane No 1A	C	0	C	0 83C	0 0	1 04	1 04	0 90	1 05	4°	Longitudinally unstable.
Biplane No 2A	C	0 50C	C	0 83C	0 0	1 04	1 04	0 98	1 08	12°	Unstable
Biplane No 3A	C	0 50C	C	0 83C	2 1	0 96	1 03	0 98	1 04	12°	Longitudinal stability for any center of gravity located within the lower triangle formed by the vectors for −2° and −5°. This will be the case for a heavy sea-plane
Reverse Curvature Wings	C	0	C	C	0 0	0 86	0 83	1 21	0 88	2°	Longitudinally stable

C = chord length (upper)
K_y/K_x and other aerodynamic coefficients referred to the orthogonal standard biplane as unity

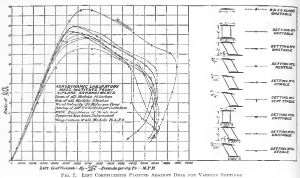


Fig. 7. Lift Coefficients Plotted Against Drag for Various Settings

to consider L/D and K_x for the same angles of incidence It really matters very little what the angles of incidence for biplane and monoplane are, provided we have the same K_y and the same sustaining power at the same speed.

From Table 4 one would conclude that the biplane has a very distinct advantage for a high-speed scout. Apparently at a high speed, and hence a low lift coefficient, the biplane resistance is 10 per cent less than the monoplane resistance. This is an appreciable saving For a machine which must fly slowly, and consequently with a high lift coefficient, the biplane resistance is from 15 to 25 per cent greater than the monoplane resistance

References for Section 8

Chapter on Aeronautics, by J C Hunsaker in the New Mechanical Engineers Handbook

The Design of Aeroplanes, by A W Judge, page 42

The Resistance of Air and Aviation by G Eiffel (translated by J C Hunsaker)

La Resistance de l'Air et l Aviation, by G Eiffel, 1914. Chapter 5

Stable Biplane Arrangements, By J. C Hunsaker in *Engineering*, Jan 7 and 14, 1916.

Dynamic Stability of Aeroplanes, By J C Hunsaker in Aviation and Aeronautical Engineering Aug 1, 1916.

Determination of the Effect on the Lift and Drift of a Variation in the Spacing in a Biplane. British Report 1911 2 No 60

Determination of the Effects of Staggering the Wings of a Biplane British Report, 1911-2 No 60

Application of Experimental Results to Practical Problems in Aeroplane Design British Report, 1911 2, No 60

Erratum

In the Course of Aerodynamics and Airplane Design, on page 188 of the October 15 issue, the paragraph directly under Fig 9 should read "The center of pressure motion is illustrated in Fig 10 It has the same peculiar characteristic for each of the wings At small angles the center of pressure moves backward, thus producing diving, while at large angles the center of pressure again moves forward, thus tending to stall the machine. Longitudinal stability is thus not secured."
—A. K.

A Wire Bender for the Airplane Factory

By E. Molloy

The object of making tools for wires, wire tangs, fair leaders, strut caps, hinges, etc, is to do away with "cut and try" methods. A little thought and time put on a tool or jig may save hours of a man's time in making up the parts, and further, such parts would be all practically alike, making them interchangeable with each other on various parts of the machine. This is further assurance of repair parts being a perfect fit either assembled on the field or in the shop

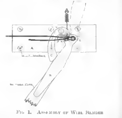


Fig. 1. Assembly of Wire Bender

Particularly where parts are being built in great numbers there is important reduction in the cost by the use of jigs in consequence of the increased rapidity with which the machines

may be made, and with the employment of cheaper labor which is possible when using tools for interchangeable parts. Also, the accuracy with which the parts can be produced, make it possible to assemble them without any great amount of work.

Fittings made of sheet cold rolled steel, cut and drilled in

Fig 2 Type of Eye Made by Wire Bender

jigs have a pleasing appearance, being without the ugly hammer marks and holes that are not centered, leaving the original smooth surface for nickel plating or painting

The individual manufacturer and experimenter will find it to their advantage to make simple jigs when they have several fittings of the same kind to make; i e elevator and flap hinges, strut fittings, wire terminals, etc.

As an instance of what can be done in this respect the following description of a wire bender may be of interest

The standard designs of aeroplanes require a great many wires, cables and solid wires. It is desired to have an equal bend or loop at each end of the wire. Fig 1 shows a wire bender of common design, which is a valuable asset to shop equipment as it saves hours of time and makes an ideal bend which is almost impossible to make by hand.

The handle B is swung back to the position shown by the dotted lines, the helical spring is attached to the bench and pulls cam D back to the position indicated by dotted lines. The straight wire is placed between pins F, E and H, H; then the handle is simply brought back to the position shown in full lines. When handle B strikes the dog C, pins H and H move equal distances toward the center which insures a uniform bend. This operation prepares the wire for the ferrule which is often made of a piece of tin wrapped around the doubled wire and soldered.

Fig 2 shows the correct form of a wire bent with this tool, with a tin ferrule in place ready for soldering. Note the even bend. When soldering, care should be taken to fill the ferrule and finish off the ends smoothly.

Fig 3 is a working drawing of the details of such a wire bender.

Medals Offered for Aeronautical Essays

To foster interest in aeronautics, the Aero Club of America has announced that it will offer medals in fifty universities and colleges to those who write the best essays on any one of these subjects: Military Aeronautics, Mechanics of the Aeroplane and Possible Technical Development in Aeronautics and the Possible Application of Aircraft for Utilitarian Purposes.

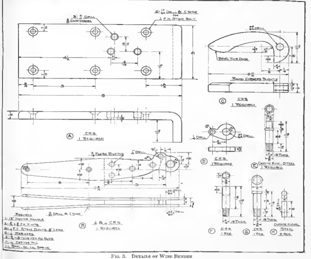


Fig. 3. Details of Wire Bender

News of the Fortnight

Government Inspectors in Airplane Factories

In view of the fact that there are over 240 airplanes with a hundred spare motors under order from ten different factories for the United States Army today, not to mention that bids have been requested for more than 130 twin-engined airplanes to be equipped with float landing gears for rising from and alighting upon the water, it is interesting to know that the technical Aero and Advisory board of the United States Army has organized a corps of inspectors of aeronautic material for the factories that are building airplanes for the government.

This corps of inspectors is under the direct charge of Henry Souther, who is assisted by Captain L. E. Goodier, U.S.A., retired. Thirty inspectors are at present employed by the Army in eight factories. Most of the men are stationed at the factories but some of them are employed traveling from one factory to another making inspections. Every new factory not at present employed upon government work, which bids upon a government contract may expect a visit from a government inspector as well as an Army officer before any definite order is placed with it.

An inspector, too, is employed with the Bureau of Standards on work in connection with the Aviation Section of the United States Army. Another inspector is at Columbus, N. M., on the border whence he makes daily reports to Washington upon the troubles which develop in airplanes under actual performance conditions.

In the Bureau of Standards tests are made on every sort of material that goes into airplanes, wood, wire, turnbuckles, linen and substitute wing coverings, aluminum alloys, steel, rubber and all of the innumerable materials that must have maximum strength and minimum weight if an airplane is to reach an approximation to perfection.

It is of paramount importance if government airplanes are to have a reasonable factor of safety that their inspection be carried on while they are in course of construction. It is impossible to make adequate tests of every spar in a completed machine. The only way that faults in a completed machine can be discovered is through an accident, apt to be more or less serious. The government is even more anxious to save the lives of men who can fly and are a real military asset already than it is to secure new fliers—though no stone is being left unturned to get fliers for the Officers Reserve Corps.

The only criticism that has been made of the inspectors is that they have, for the most part, received their training in the automobile business. Henry Souther, the chief inspector, was engaged in the bicycle business at the time the late Professor Langley thought it worth while to consult him on stresses and strains upon the materials he was putting into his ill-fated machine.

The choice of automobile men for inspectors is logical from every point of view. They are accustomed to submitting materials to breaking strains. They are accustomed to inspecting parts and their eyes are trained to note any deflection from an accurate fit. They are men who can tell at a glance whether a welding or brazing job is being properly or improperly performed. Another advantage of having a corps of inspectors is that the government now knows just exactly how nearly complete every single airplane under order is.

The inspectors for the United States Army are employed in examining all sorts of aeronautical accessories as well as airplanes themselves. In this way motor trucks, hangars, motor cycles and innumerable other adjuncts that are necessary for an aero squadron in the field are being looked into with a critical eye toward their suitability for aeronautical service.

New Curtiss Winter School at Miami

Glenn H. Curtiss has announced that he has selected Miami, Fla., as a winter flying base after an investigation of several sites. On his return from the South, he is quoted by the newspapers as saying:

"I have selected Miami because of its stretch of beaches. The training school will be transferred there from Newport News, to be tried out during the winter experiments."

Recruits Wanted for Aviation Section

A communication has been sent out by Adjutant-General G. W. Read to United States Army recruiting officers instructing them to enlist men for the aviation section. Positions awaiting volunteers are for photographers, telephone and radio operators, electricians and mechanics.

Army Notes

The United States Army is teaching civilians how to teach aviation in the way the Army wants it taught. One school for instructors has been established at Mineola and it is understood another will shortly be inaugurated at Omaha. Student instructors at these schools will occupy a status of civilian employees, and under the Defense Act the War Department is authorized to pay them $100 a month. When they qualify as instructors they receive $300 a month. From this grade they are promoted to senior instructors at a salary of $350 a month, and later to chief instructors at a monthly salary of $400. Chief instructors receive an increase of $200 for every year's service until they reach the maximum pay of $6,000 a year. With such inviting opportunities for civilians it is expected that some of the most daring flyers will become candidates for instructors. It is stated that there are comparatively few aviator instructors in the country. Many excellent and daring flyers have had no experience in the instruction of students.

There is a very gratifying prospect of securing an excellent corps of Reserve officers for the Signal Corps. The Aviation Section has received about 1,200 requests for blanks from candidates for the Reserve Corps. The candidates who qualify physically and comply with the educational specifications set forth in G. O. 55, War Department, Oct. 16, but cannot come up to flying qualifications, will have an opportunity to enlist as non-commissioned officers and will be sent to the school for instruction. When they qualify as officers they will be commissioned. Eight candidates for Reserve officers reported for examination at Washington on Oct. 31. The board which is conducting the examinations consists of Major A. W. Williams, Med. Corps, Capt. Thomas De Witt Milling, Signal Corps, and Capt. H. W. Harms, Signal Corps, U.S.A.

Captain Chandler, who is in charge of the Army's lighter than air work is pushing his plans ahead rapidly. Bids have been received from four companies for the four lighter than air craft that the Army is ready to buy. Contracts will be awarded at once. One captive balloon of 25,000 cubic feet capacity, two of 35,000 cubic feet capacity and a kite balloon of 30,000 cubic feet capacity will be ordered. Fort Omaha, it has practically been decided, will be the headquarters for the Army's lighter than air work.

Oregon Guard May Have Aero Company

Oregon's National Guard may have an aviation corps if an offer just made by the firm of Martin & Strohman, manufacturers of flying machines in Portland, Oregon, is accepted. A tender of the frame of an aeroplane, complete in every way, has been made to the National Guard of that state, provided that some one will donate the engine.

The offer has come to the attention of the Chamber of Commerce, and an opportunity will be given to some members of the business community of the city to provide the motive power for the flier. It is realized that the aviation branch of the service is an important one, and it is desired to interest Portland people in getting the first.

The Oregon National Guard can take advantage of this offer by detailing two officers of instruction to the Army Aviation School at San Diego, Cal. When they are trained as Junior Military Aviators and have enlisted the required personnel they will receive provisional recognition from the Federal authorities, and when they have six flying officers and thirty nine men trained as mechanicians, etc., they will receive Federal recognition, and the Federal authorities will supply the Aero Company, with a full complement of six aeroplanes, with spare parts, motor trucks, machine guns, ammunition, etc.

Federal Flying School at Essington

Preparations have been completed for establishing a Federal Aviation School adjacent to the Philadelphia Navy Yard, and in Councils, Chairman Gaffney, of Finance Committee, has introduced an ordinance to lease the old quarantine station known as the "Lazaretto," at Essington, which the city owns, to the Federal Government for the purpose. The property is now utilized by the Philadelphia School of Aviation, on a nominal lease with the city, and since the government desires to establish a school along a navigable waterway for use of water fliers, the Essington site has been recommended.

The National Aeroplane Fund Report

The annual report of the National Aeroplane Fund of the Aero Club of America has been made public. The report states that the sum of $171,031.17 was received by the trustees of the fund of which $147,314.92 had been expended up to the date when the report was issued. Of the balance, $23,716.25, the sum of $20,000 has been set aside in special deposit for prizes in a trans-continental airplane flight which it is proposed to hold next year.

The largest contributor to the fund was Emerson McMillan, who gave $33,956.15 A brief summary of the finances of the fund compiled from the statement made public by the club is as follows:

RECEIPTS

Emerson McMillin	$33,956.16
Miss Nicherson	7,500.00
Other contributions	129,575.02

EXPENDITURES

Publicity		
Salaries	$19,432.16	
Stationery, printing engraving etc	17,775.61	
Postage	10,197.24	
Multigraphing	12,166.79	
Prizes, demonstrations, exhibitions for airplanes and models	5,403.71	
Total Publicity		$66,681.51
First Aero Company N G N Y		21,835.72
Rhode Island Militia		7,500.00
National Guard, New Mexico 1 battleplane—value		7,500.00
Massachusetts California, New Jersey Guards (about)		7,000.00
Traveling Expenses, National Guard Officers		10,445.00
Cash on hand in General Fund Sept. 30 1916		2,839.49
Cash on hand in special deposits		22,000.00
Unitemized (about)		25,000.00

The report and audit were accepted by the Board of Governors of the Aero Club of America As shown on the report, the administrators of the fund served without compensation In the publicity campaign it is stated that over 2,000,000 pieces of literature were sent broadcast over the United States.

Lieuts. Bronson and Welsh, U.S.N., Killed Testing Bomb

In an attempt to launch a bomb from their airplane at the Indian Head Proving Grounds on November 8, Lieutenant Luther Welsh, U S N., and Lieutenant Clarence K. Bronson, U. S. N., were killed by the premature explosion of the missile The wreckage of the machine and the bodies of the two men fell into the Potomac River

The men were engaged in experimenting with bombs for use against vessels, according to the Inspector of Ordnance at Indian Head, who added:

"The bomb detonated immediately beneath the airplane It was being launched by Lieutenant Welsh and apparently struck some part of the machine It was seen to detonate and the airplane broke in two and fell into the river Hardly any trace of airplane or passengers has been found yet."

A search party proceeded at once to the scene of the wreck, the Navy Department announced, and dragged the river.

Lieutenant Bronson, at the time of his death, was detailed for aviation instruction at the Curtiss Aviation Station, Newport News, Va. He had been attached during the last two years to the aviation school at Pensacola. He was piloting the machine when the accident occurred Lieutenant Welsh was detailed as ordnance officer to the Indian Head Proving Grounds.

A Rhode Island Aeroplane Company

Articles of incorporation for the Stephens Aeroplane Company were filed in the office of the Rhode Island Secretary of State recently. The incorporators are Bruneau Stephens, Arnold B. Stephens and Lorne E. Stephens, all of Providence, and they plan to engage in the buying, selling and operating of agencies of air craft. The capital stock of the company is placed at $100,000.

Kopseker Making Alterations

William A. Kopseker of Topeka, Kan , is altering his original design for an aeroplane from a monoplane to a biplane prior to its initial flight. Kansas newspapers give the following description of the machine:

The aeroplane is equipped with a 40-60 horsepower engine, a 7 foot 6 inch propeller, and it weighs between 600 and 650 pounds when rigged ready for use. The monoplane has a spread of 29 feet 8 inches. When it is converted into a biplane its wings will reach 26 feet 6 inches.

Captain Byron Q Jones, U S.A , tested one of the Sturtevant 135-horsepower, all steel two-place reconnaissance tractors on October 27, executing sharp spirals, nose dives and stalls. San Diego newspapers are authority for the statement that the airplane "is as free from structural defects as the north pole is from flies" The Sturtevant Company announces that the government has ordered eighteen additional S-4 machines in the past few days

Death of Silas Christofferson

Silas Christofferson, consulting engineer of the Christofferson Aircraft Manufacturing Company, was killed on October 31, when his machine overturned in a fall of 100 feet during a trial flight of a new military airplane

Christofferson was flying over the aviation field at a height of several hundred feet when his engine went dead He glided to an approximate height of 100 feet, but seemed to lose control of his plane, and plunged to earth, the machine turning over upon him

His wife and two brothers were watching the flight, and rushed to his aid, with Miss Eugenie Doty of San Francisco, an aviation pupil. The injured aviator was hurried to a hospital, but expired soon after reaching there

Christofferson took up aviation in 1910 His most noted flight was several years ago, between San Francisco and Los Angeles, over the Tehachepi mountains.

William Earl Dodge Plans a Flying School

F C G Eden, representative of William Earl Dodge of New York, is busy with plans and arrangements for the flying school which Mr Dodge hopes to start and finance through the winter for the training of sixteen college men in aviation. Mr Eden has written to the War Department for suggestions and approval of his plans and when the flying field has been put in shape and the equipment, which will consist of three airplanes, one built for alighting upon the water, the other two for alighting on the land, has been secured an officer will pay a visit of inspection to the field.

Anthony (Tony) Jannus Is Dead

Anthony (Tony) Jannus of Baltimore, an American aviator, was killed in the Russian aero service, October 12 last. No details of how Jannus died have been received. He was an instructor at the Canadian Aeronautical school at Toronto, for a time, during 1915, and first gained fame as an aviator in a Benoist machine at Kinlock park, St Louis

Friends in Baltimore said Jannus went to Russia several months ago to sell American machines to the Russian government and to supervise the delivery of the machines along the eastern war front.

Exports of Airplanes

Special Monthly Statement Number 41 issued by the Bureau of Foreign and Domestic Commerce of the Department of Commerce, Washington, D. C , signed by John Hohn of the division of statistics reports that one airplane valued at $5,000 was exported from the United States during the month of September, 1916

An Aluminum Soldering Process

The National Solder Company has perfected a process for soldering aluminum, and is ready to make tests for any airplane factories of their product. Some samples recently tested at the Pittsburg Testing Laboratory were submitted to breaking strains, or almost to breaking strains, and the laboratory made the following report on the product:

Description	Dimensions	Area	Maximum Load, Pounds	Tensile Strength Lbs. per Sq. In.	Elongation In 8 Inches	Elongation Per Cent	Fracture
No. 1 Lap Joint	1.011" x .502"	.5096 sq. in.	6,000	11,770	.44"	8.8	Broke in weld
No. 2 Lap Joint	1.003" x .490"	.4924 sq. in.	5,800	11,780	.44"	8.8	Broke in weld
No. 3 Butt Joint	1.005" x .501"	[illegible] sq. in.	4,300	8,[illegible]	.08"	1.6	Broke in weld
No. 4 Butt Joint	.998" x .498"	[illegible] sq. in.	[illegible]	[illegible]	.09"	[illegible]	Broke in weld
No. 5 Plain Aluminum	1.010" x .498"	[illegible] sq. in.	8,450	16,800	.50"	10	Silky
No. 6 Plain Aluminum	1.031" x .497"	[illegible] sq. in.	8,700	16,880	.65"	13	Silky

The manufacturer claims that their solder flows readily at a temperature of 350 degrees Fahrenheit.

Curtiss Notes

The twin motored "air cruiser" recently tried out at Hammondsport, and which carried twelve men on one short trial flight, has been sold to the American Trans-Oceanic Company of Port Washington, L. I. The machine has been delivered and is being assembled.

The little triplane scout has been brought into the Experimental Department and improvements are being made to increase still further its speed and climbing ability. An effort is also being made to reduce the slow speed of the machine. It will probably be tried out at Newport News, Va., late this month.

IT IS REPORTED THAT—

PETER C. ("TEX") MILLMAN and MISS MAY SCHULTZ were married at Mineola, N. Y., October 12.

BILLY T. COOK and J. R. HUTCHINSON have located their Davenport Aviation School at New Orleans for the winter. They will be ready for students about December 1. They will retain their factory at Davenport.

THE FEDERAL CIVIL SERVICE COMMISSION has announced that an examination will be held on November 21 for candidates wishing to qualify as inspectors of aeronautic material.

Aeronautical Patents

Copies of these patents may be obtained for five cents each by addressing the "Commissioner of Patents, Washington, D. C."

ISSUED OCTOBER 31, 1916

1,203,558 Filed April 4, 1914. To Edson F. Gallaudet, Norwich, Conn. Airplane with rigidly mounted integral wing structure with tips flexible and rearwardly projecting.

1,203,218 Filed January 27, 1913. To Alfred J. Macy, Chicago. A stabilizing device for vehicles intended to move normally other than on the ground.

1,203,220 and 1,203,221 Filed July 28, 1913. To Alfred J. Macy, Chicago. A stabilizing device for vehicles comprising a container, a plurality of longitudinal and transverse electric contacts therein and unstable single solid vibratory element adapted to connect all of the electrical contacts with a source of electro-motive force.

ISSUED NOVEMBER 7, 1916

1,204,980 To Glenn H. Curtiss, Hammondsport, N. Y., assignor to Curtiss Aeroplane and Motor Corporation. Filed June 23, 1916. Flying machine with interplane ailerons.

The Official Gazette of the United States Patent Office for Tuesday, October 31, 1916, page 1539 contains the decision of the Court of Appeals of the District of Columbia in Janin vs Curtiss decided June 1, 1916. Judge Van Orsdel in the court decision held Janin to be the inventor of and to have the rights in basic patents upon heavier than air flying machines adapted to alight on water and arise therefrom by their own power. Mr. Justice Robb dissented.

Classified Advertising

10 cents a word, minimum charge $2.00, payable in advance. Positions Open or Positions Wanted advertisements, no charge (20 words). Address replies to advertisements with box numbers, care of AVIATION AND AERONAUTICAL ENGINEERING, 120 West 32d Street, New York.

FOR SALE—Seven cylinder, 70 horsepower rotary motor, with Excelsior propeller $450.00 Address Landsmann Motor Co., 1406 S. 18th St., St. Louis, Mo.

AN EXPERIENCED AVIATOR, who has seen service in France and Belgium, is desirous of establishing a connection with some reliable firm as demonstrator, instructor, etc. Would consider flying for moving picture firm. Experienced in looping banking and all the tricks of aviation, and not afraid of work in this line. No position considered at less than $600.00 per month. Correspondence confidential. Address Box 42

YOUNG MAN, college graduate, and thoroughly familiar with gas engines, desires position with airplane company. Best references. Address Box 9

AGENTS wanted in every city for AVIATION AND AERONAUTICAL ENGINEERING. An especially liberal offer is open for the months of September and October. Address Circulation Managers, AVIATION AND AERONAUTICAL ENGINEERING, 120 West 32d St., New York

YOUNG MAN doing exhibition work, desires to learn aviation. Address Box 8

EXPERIENCED YOUNG AERONAUTICAL ENGINEER desires position as assistant or in charge of experimental work. Small, live company preferred. Address Box 14

$635 gets 6-cylinder 85 horsepower Aeromarine motor taken for debt. Identical with motor used by Art Smith. Double oiling system. 2 independent magnetos. In excellent condition; recently overhauled at Aeromarine factory. Address, Box 6.

YOUNG MAN experienced on aerial engines seeks position with reliable concern manufacturing Aircraft. Wants instruction in flying. Address, Box 47.

YOUNG MAN with good habits, machinist, desires position with reliable aeroplane company to learn aviation and become aviator. Address Box 21.

FOR SALE—Single passenger training biplane equipped with 3 cylinder 35 H. P. Anzani motor. Motor and plane both brand new. Ideal equipment for beginner to use as penguin or for short flights. Can be seen at U. S. Army aviation field at Mineola. Property of 1st Aero Company U. S. Government desiring to standardize equipment for school work did not take over this plane, which is in perfect condition. Address Box 5

HOW TO UNDERSTAND AEROPLANES, by S. L. Walkden. Fourth edition, enlarged. Contains exclusive matter. 40 000 sold. 125 pages. 88 figures and illustrations. Price $1.00 post paid. W. E. Walkden, 2969 Fifth St. San Diego, Calif